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Vehicle rooflining and method for producing the same

The present invention relates to a vehicle rooflining according to the pre-characterising clause of Claim 1 and a method for producing the same.

This vehicle rooflining is characterised by an especially good acoustic behaviour and is suitable for an ultra-light construction.

Because of their low intrinsic stability, large area vehicle parts, especially vehicle roofs, tend to deform, vibrate and oscillate during driving. This behaviour is conventionally counter-acted by applying insulating material, especially heavy layers of bitumen. In order to reduce the transmitting of driving noises into the vehicle compartment, the automotive industry has used multi-layer sound insulating systems for some time now. As a rule, these sound insulating systems are designed as spring-mass systems and comprise an air-tight heavy layer coupled with a resilient layer in order to absorb the vibrations of the large area body parts and insulate sound transmission.

A sound insulation system of this kind is disclosed in EP-0'255'332, for example, and comprises a semi-flexible support layer with which the rooflining can be braced against the vehicle roof in the manner of a snap connection. A classic spring-mass system with a resilient, sound-absorbing foam layer and a visco-elastic, closed cell heavy layer (filled with bitumen) is pressed against the vehicle roof with this support layer.

For example, a sound-absorbing rooflining is known from EP-0'637'820, which essentially comprises a semi-rigid PU foam layer, approximately 5 mm - 15 mm thick, and a 4 mm - 10 mm

resilient nonwoven fabric layer, both layers being air-permeable. In the case of this embodiment, the foam layer is reinforced both sides with glass fibres and has an air-permeable decorative layer on the passenger compartment side. The individual layers are bonded to each other with an air-permeable adhesive, especially a PU adhesive. This sound-absorbing rooflining is also a classic spring-mass system.

However, it has been found with this type of rooflining that because of the open cell construction of these sound absorbers, their adhesive components penetrate the decorative layer relatively quickly when these rooflinings are made and result in visually perceptible stains and therefore to a relatively high rejection rate. Therefore, the use of permeable layers leads directly to an undesirable detrimental effect on the appearance of the rooflinings.

In addition, spring-mass constructions always lead to resonance interference in the sound insulation, which is normally in the frequency range of the lower engine orders and is especially undesirable there.

However, the general objective of the automotive industry is to reduce the weight of vehicles. This has the result that thinner and lighter body and lining parts are being increasingly used and these can result in considerable acoustic problems.

Therefore, it has already been suggested in FR 2 503 721, for example, that a light rooflining be made which essentially consists of an open cell and glass fibre-reinforced foam layer which is covered with a decorative layer and has an air-impermeable polyethylene foil between

this decorative layer and the glass fibre-reinforced foam layer to prevent the permeating of adhesive components into the decorative layer. On account of this foil, this suggested rooflining has a poor acoustic absorption which could be improved at best by perforation. However, perforation of the PE foil in this manner can lead to visually perceptible changes in the decorative layer. In the case of the manufacturing method disclosed in this specification, the back layer on the roof side is perforated, i.e. air-permeable, and therefore conflicts with modern legal regulations concerning the design of vehicle linings. These regulations forbid a direct air flow between vehicle roof and passenger compartment.

Therefore, the object of the invention is to create a rooflining which, depending on its specific use, has optimum sound absorption and an aesthetically-resistant appearance at the same time.

This object is achieved according to the invention by a lining with the features of Claim 1 and especially in that a semi-permeable and migration-resistant barrier layer is provided between an air-permeable decorative layer and a multi-layer structure element. The multi-layer structure element is also air-permeable and has a support layer, especially a PU foam layer, which is provided both sides with an air-permeable reinforcement layer especially made from glass fibres. These layers are bonded together in a known way. The decorative layer may consist of a non-woven fabric or another air-permeable material, e.g. a knitted glass fabric. The semi-permeable and migration-resistant barrier layer used according to the invention is impermeable for and migration-resistant against the adhesive used, or their components or additives on the one hand and is micro-porous on the other, i.e. air-permeable,

and has a thickness of $0.1 < d < 1.0$ mm and is designed in such a way as to produce an air flow resistance of 500Nsm^{-3}, $< R1 <$ 2500Nsm^{-3}, especially of 900Nms^{-3} $< R1 <$ 1900Nsm^{-3}. It is important for optimising the acoustic effectiveness of the vehicle rooflining that the air flow resistance on the passenger compartment side is in the desired range. In addition, the air-permeable, i.e. open cell barrier layer, is made from a material which is semi-permeable and migration-resistant and especially prevents the penetration or permeation and / or migration of the adhesive used, or its components and / or the softeners used, the decomposition products caused by ageing and / or the additives from the PU foam layer or the adhesive layers. These barrier layers are available on the market and are made from chemically-bonded cellulose and polyester fibres, for example.

One preferred method for making a lining according to the invention provides for depositing reinforcement fibres, e.g. glass fibres or polyester fibres, on a continuously unwound bottom layer or back layer, especially in polyethylene, and applying a continuously unwound support layer, especially a PU foam layer, to it. This layer sequence in the form of a sheet is impregnated with the first component of an adhesive, especially a PU adhesive. According to a preferred embodiment, this layer sequence is transported as sheet through a bath filled accordingly. In order to be able to control the amount of the first adhesive component applied, this impregnated layer sheet is transported through a pair of squeezing rollers. Reinforcement fibres are again applied to the layer sheet treated in this way and a second

adhesive component is sprayed on before a semi-permeable and migration-resistant barrier layer is applied and pressed onto the other layers. A decorative layer, e.g. a 100 g/m^2 PE non-woven fabric, is applied to this barrier layer.

The sheet made in this way is then cut into suitable pieces and shaped in a known way, i.e. with heated moulding press dies, in order to obtain the vehicle rooflinings wanted.

Naturally, the materials for this lining and the chemicals needed to make this lining are not limited to the selection disclosed here as an example. A person skilled in the art will choose suitable materials and chemicals depending on the range of application of the product according to the invention. Naturally, the continuous manufacturing method disclosed above may also be carried out sheet by sheet or step by step.

The invention is explained in more detail below on the basis of the diagrams and an example of an embodiment, where:

Fig. 1 shows a diagramatic section diagram of the construction of a lining part according to the invention;

Fig. 2 a diagramatic section of the method for making a lining according to the invention.

Fig. 3 a comparative graph of the frequency-related sound absorption of the lining according to the invention.

Figure 1 shows a diagram of the construction of a lining according to the invention. This lining has a central support layer 3, which consists of an air-permeable material, preferably an open cell PU foam. In a preferred embodiment, this foam layer 3 has a thickness of approximately 5 mm to 30 mm, especially 20 mm, and has a volume of 20 kg/m^2 to 60 kg/m^2. A reinforcement layer 4 and 5 is disposed on each side of support layer 3, respectively. Preferably, these reinforcement layers are made from glass fibres and are bonded to the support layer 3 with an adhesive 7. According to a preferred embodiment, a glass fibre layer with a weight per unit area of approximately 50 g/m^2, whose thickness corresponds approximately to 1 to 3 times the diameter of the fibres, is used on both sides. Naturally, other suitable materials, i.e. rigid materials, may be used for the reinforcement layers. It is essential for the present invention that the aforementioned individual layers are air-permeable and that adhesive 7 also allows an air flow through these layers. An air-impermeable back layer 9, preferably in polyethylene, is provided on the vehicle roof side. This back layer 9 prevents air from being able to flow from the passenger compartment through the air-permeable lining 1 into the space between the vehicle roof 2 and the lining 1. An air-permeable decorative layer 6, e.g. a 100 g/m^2 heavy PE non-woven fabric, is applied on the passenger compartment side. According to the invention, a micro-porous, semi-permeable and migration-resistant barrier layer 8 lies between the decorative layer 6 and the support layer 3. In a preferred embodiment, this barrier layer 8 is made from cellulose and polyester fibres bonded together and is gas-permeable, especially air-permeable, on the one hand but impermeable on the other, i.e. impermeable for at least the liquid or viscous substances used when making the lining, especially adhesive

components, and therefore acts as a barrier layer for the adhesive 7 used. In addition, this barrier layer 8 is made from a material which prevents the migration of adhesive components, any softeners, decomposition products caused by ageing and / or chemical additives. The air-permeability is achieved by the micro-porous and air-permeable structure of this barrier layer 8. The air flow-resistance through this layer 8 can be pre-determined especially through the choice of fibre diameter, barrier layer density and its thickness. In a preferred embodiment, this barrier layer 8 has a thickness of $0.1 < d < 1.0$ mm and is designed in such a way to produce an air flow resistance of $500 Nsm^{-3} < R1 < 2500 Nsm^{-3}$, especially $900\ Nsm^{-3} < R1 < 1900\ Nsm^{-3}$ in the lining layers on the passenger compartment side. The surfaces of this barrier layer 8 can be treated, i.e. wetted, for the adhesives interacting with the surfaces, whereas the centre area of this barrier layer 8 can have a pronounced repellent effect for these adhesives. Suitable surface treatments, e.g. scarfing, with chemical primer or corona treatment, are known to a person skilled in the art. The wetting capability of these barrier layer surfaces is chosen in such a way that these surfaces enter into adhesion with the adhesives used, but these adhesives cannot form any closed, air-impermeable film. In this preferred embodiment, a barrier layer of polyester and cellulose fibres with a weight per unit area of 20 g/m^3 to 60 g/m^2, especially 40 g/m^2 is used. The weight of the adhesive necessary is approximately 60 g/m^2. A lining with a total weight of approximately 800 g/m^2 and a thickness of approximately 22 mm can be made with this.

The method illustrated in Fig. 2 for making a lining according to the invention uses a thin back layer 9 which is taken down continuously from a roll. Preferably, this back layer consists of polyethylene and serves as an

impermeable under layer to which the other materials are applied. In a first method step, reinforcement fibres 11, especially glass fibres, are strewn loosely over this back layer 9. A support layer 3, especially a PU foam layer, is then placed on these glass fibres 11. This support layer 3 may also be drawn down from a roll. In a further step of the method, these three layers 9, 11, 3 are transported through a bath 13 which contains a first adhesive component. To be able to control the amount of this adhesive component applied, this impregnated layer sequence is transported between two first squeezing rollers 14. After this squeezing process, reinforcement fibres 15, especially glass fibres, are scattered on again and then sprayed with a second adhesive component 16. The micro-porous, semi-permeable and migration-resistant barrier layer 8 is applied to the material sheet treated in this way and pressed with the aid of a second pair of squeezing rollers 17. A decorative layer 6 is applied in a next method stage. This material is then cut to size and transformed into the required shape in a heated press die. Naturally, the continuous manufacturing method disclosed here as an example may be simply modified by a person skilled in the art to form a discontinuous, i.e. step-by-step manufacturing method.

The curves shown in Fig. 3 show the acoustic effectiveness of the lining according to the invention. In this case, curve A represents a sound absorption behaviour of a vehicle rooflining without barrier layer 8 according to the invention. It is evident from this curve that an absorption of more than 0.8 can be achieved through the open cell construction of the layers on the passenger compartment side. However, such high absorption coefficients are undesirable in the vehicle acoustics range, because this greatly prejudices the intelligibility

of speech in the passenger compartment. The path of this curve (a) also shows inadequate absorption of the vehicle rooflining in the range below 1500 Hz. On the other hand, curve (b), characterising the absorption behaviour of the lining according to the invention with micro-porous barrier layer, shows that this rooflining already has satisfactory absorption at frequencies of 800 Hz and the absorption coefficient for higher frequencies fluctuates in the range between 0.7 and 0.8. This comparison illustrates the advantages obtained with the vehicle rooflining according to the invention.

Naturally, other embodiments of this vehicle rooflining are within the range of the normal technical scope of a person skilled in the art. With his knowledge, a person skilled in the art will especially choose suitable materials and adhesives for making a vehicle rooflining according to the invention. The special fashioning or shaping of the rooflining also belongs to the normal technical scope of a person skilled in the art.